IES Newsletter

Volume 18, Number 6
November - December 2001

Editor's Note

We typically focus on IES research or education programs in our newsletter cover stories. In this issue, however, we have taken a break to perform a public service, of sorts.

The threat of anthrax has made us all aware of those microscopic entities called spores. Now, with the invaluable assistance of Dr. Jonathan Cole and Ms. Judy Sullivan, two IES employees who have more than a casual aquaintance with spores due to the nature of their work, we are attempting to put these very interesting structures in perspective.

On a related note, winter is always a wonderful time to visit the greenhouse. While you're there, take a look in the Fern Cases, in Unit 6, where sporophytes and gametophytes are growing. Sullivan, who is raising them, says they will be ready for planting in the Fern Glen, or for sale at an IES Plant Sale, in 2003.

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Give Them a Spore-ting Chance ...

Before early October 2001, do you remember ever seeing the word "spore" on the front page of the daily paper, or hearing it spoken on the nightly news? Then, literally overnight, with instznces of anthrax exposure made public, spores became infamous, the "bad guys" *du jour*. Do these ubiquitous biological structures deserve such notoriety?

The term spore refers to different things in different branches of the biological sciences. In higher plants, whose reproductive cycle includes an asexual — not involving fusion of male and female cells — and a sexual phase, spores are the inconspicuous reproductive agents of the former.* In non-seed bearing plants (algae, liverworts, mosses and ferns), spores function much like seeds. And in the simplest organisms, including bacteria, algae, and protozoa, spores — called endospores, akinetes or cysts, depending on the organisms that produce them — are resistant structures formed by those organisms to aid in dispersal or in resistance to adverse environmental conditions. Let's consider these kinds of structures first, starting with what brought up the subject in the first place.

When reporters speak or write of "anthrax spores" what they really are referring to are bacterial endospores. The function of a bacterial endospore, or bacterial spore as it is sometimes called, is survival during unfavorable conditions: the spore forms within a bacterial cell to become one of the most resistant structures known to biology, able to withstand heat, desiccation, and many chemicals including antibiotics. It can remain inactive but alive for long periods, even centuries.

Only a few genera of bacteria form endospores, the two best known being *Bacillus*, which includes *Bacillus anthracis* (anthrax) and other species, and *Clostridium*, which includes *Clostridium botulinum*, the organism that causes botulism, and *Clostridium tetani*, which causes tetanus. The two genera, *Bacillus* and *Clostridium*, are not closely related genetically but are ecologically similar in some respects. Most of the spore-forming bacteria, including these, are found naturally and extensively in most soils. The soil environment fluctuates dramatically in temperature and dryness; endospore formation is an adaptation to these fluctuations, occurring when growth conditions are poor. Then, when conditions turn favorable, the endospore germinates, becoming an active, growing bacterial cell once again. Organisms like *Bacillus anthracis* or *Clostridium tetani* are what microbiologists call "opportunistic pathogens": they cause infection only incidentally. *Bacillus* grows best under aerobic conditions (where oxygen is present) but can tolerate some degree of anoxia. *Clostridium* is a strict anaerobe, which means that it cannot tolerate oxygen. Thus, the spores of *Bacillus anthracis* are quite happy to grow in your lungs while the spores of *Clostridium tetani* do much better in a deep puncture wound.

Other organisms guard themselves during unfavorable environmental conditions in similar ways. Cyanobacteria (formerly called blue-green algae) are a common group of photosynthetic organisms that live in both soil and water — in fact, the most abundant photosynthetic organisms on Earth are a genus of ocean-dwelling cyanobacteria.

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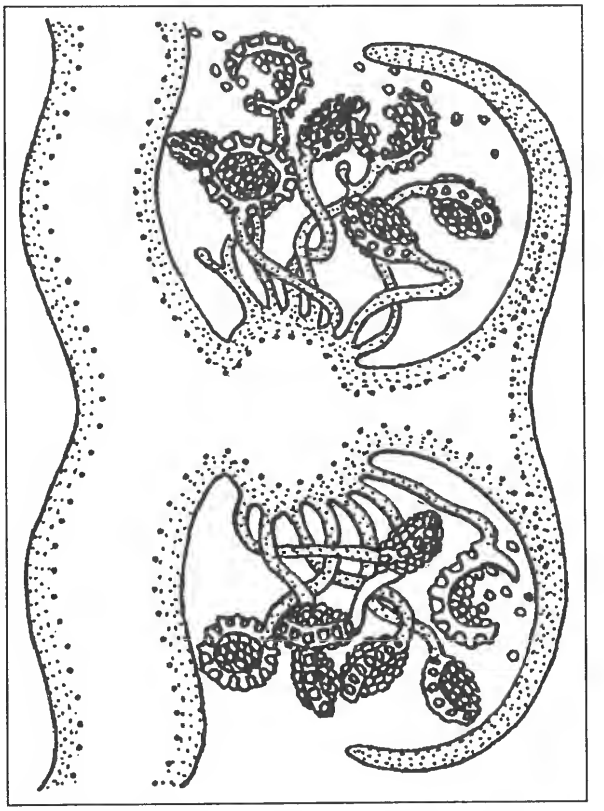

A cross section of fern sporangia dispersing spores. The sporangia are grouped in a sorus on a fern frond.
Illustration courtesy of BIODIDAC: http://biodidac.bio.uottawa.ca

* If you'd like to learn more about the biology of higher plants, why not take "Basic Botany", offered by the IES Continuing Education Program in February?

Spores, *from page 1*

Resting spores, called akinetes, are formed by some species; like the bacterial endospore, these akinetes are an adaptation for survival, and are extremely resistant to most adverse conditions. Similarly, protists — unicellular algae and protozoans — can enclose themselves in protective cysts under adverse conditions, thus resisting desiccation and temperature fluctuation.

In many organisms, spores are not only adaptations for survival but also are part of the reproductive process. Fungi (mushrooms and their relatives), for example, produce both asexual and sexual spores. Asexual spores, which grow on thread-like hyphae, can resist drying but are not very resistant to heat and are not capable of sustained dormancy. Sexual spores, produced and released by above-ground fruiting bodies, such as mushroom caps, although nothing like the much more resistant bacterial endospore, can resist heat and can sustain dormancy. Under suitable conditions of moisture, temperature and nutrient availability, fungal spores germinate and grow into new individuals.

Once we move to the higher plants, spores serve solely a reproductive function. With the IES Fern Glen displaying over 25 native ferns, 6 fern allies, and 12 mosses, it seems appropriate to look at the place of spores in the biology of what are called the lower vascular plants.

Fern spores are no larger than a speck of dust, and one frond of one small fern can produce over 700,000 of them. An epidemic of ferns and mosses, however, is not likely: the spores are produced in such vast quantities to enhance the odds of at least a few landing in a favorable spot and surviving. Spores are contained in tiny pouches (sporangia), which, in turn, are grouped into dots, streaks, or "crochet hooks" on the undersides of the fronds or, sometimes, in separate spikes (e.g., ostrich fern).

A fern's reproductive process starts with a single cell in the sporangium. This cell, which has the same number of chromosomes as the rest of the plant, divides and divides and divides again to produce "spore mother cells". The spore mother cells divide again, either once or twice depending on the type of fern, making 32 or 64 spores. Along the way, the chromosome number is reduced by half in each of the little cells, so that each spore contains only half the chromosomes of its parent.

When mature, spores are cast to the wind via a botanical slingshot called the "annulus", a row of thickened cells along one side of the spore pouch that reacts to changes in moisture. When the annulus dries out, the tension mounts until it snaps, flinging the spores a distance from the parent fern. If they land in a moist shady spot, these minute single-celled reproductive packets start to grow and eventually form prostrate heart-shaped plants called gametophytes, no larger than 1.3 centimeters (one-half inch) in size, with their own simple "root" system (rhizoids) to absorb water and nutrients.

On their undersurface, gametophytes grow microscopic, bumpy antheridia (male organs) and chimney-shaped archegonia (female organs) that produce, respectively, sperm and eggs. Fertilization occurs, and the resulting egg — which now carries the full complement of chromosomes — eventually grows into the sporophyte: the fern.

So, sometimes, spores may be very bad indeed. However, most of them, most of the time, are invisibly and innocuously helping to sustain the lives of the myriad single-celled organisms, fungi and higher plants without which we could not survive. ●

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Editor's note: Many thanks to Dr. Jonathan Cole, an aquatic microbiologist at the Institute, for sharing his knowledge about bacteria, algae and fungi, and to Ms. Judy Sullivan, IES native plant gardener, for her fern expertise.

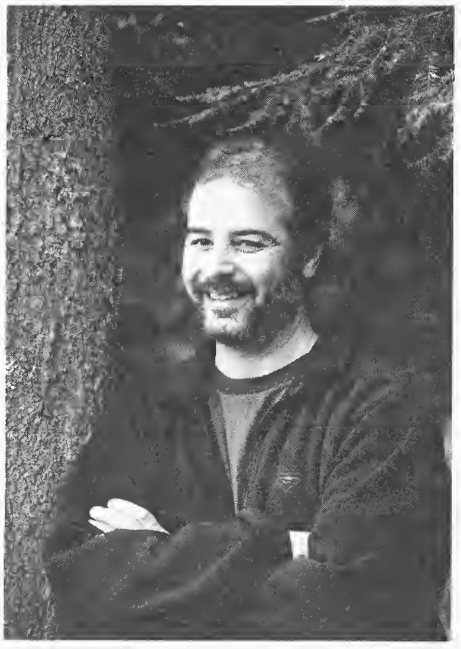
Venterea Wins Award for Research

Nitrogen (N) compounds — specifically nitric oxide and nitrous oxide — are released as gases from agricultural soils that receive N-containing fertilizers. Fertilizers also cause an increase in soil acidity when applied continuously over many years, and, as it turns out, this acidity also can enhance the amount of fertilizer that ends up being emitted as a gas. The net result, then, can be not only a decrease in productivity due to the loss of fertilizer, but also a reduction in air quality, since these gases contribute to tropospheric ozone production, acid rain, stratospheric ozone depletion, and even to global warming.

As a doctoral candidate at the University of California-Davis, Rodney T. Venterea made important discoveries related to these issues, analyzing what the biological, chemical and physical properties of agricultural soils have to do with nitrogen gas emissions. Now an IES post-doctoral associate, Dr. Venterea recently received the Emil Truog Award from the Soil Science Society of America (SSSA) for his doctoral dissertation reporting these findings.

At the Institute, Venterea (right), who collaborates with Dr. Peter Groffman, is studying forest soils in the Northeast. Northeastern forests receive N inputs in the form of atmospheric pollution rather than from direct application, and, due both to the geology and the predominant vegetation, their soils are naturally acidic. Venterea hopes to learn how these deposited N compounds interact with acidity in this context to affect gas production and re-emission back to the atmosphere.

The award is named for Emil Truog, a pioneering soil scientist and a founding member of the SSSA, which supports research and education in soil science. With the recognition that soils are the basis of all terrestrial ecosystems, and dictate the types of microbes, plants and animals that live in these ecosystems, over the years the society's emphasis has evolved primarily from its agricultural roots to address broader ecological concerns. Venterea, a soil scientist whose doctoral research could be a textbook example of what basic ecology is all about, was nominated for the award by the Department of Land, Air and Water Resources at UC-Davis. ●



LONNA KELLY

New Home for Weather Station Instruments

Looking west from Lovelace Drive, en route from the Fern Glen to the Lowlands on the Institute's internal road system, the site looks like a little settlement: several small buildings, a fence, buckets on tall tables.

Buckets on tables? Wait a second. What IS this place?

A weather station to collect the meteorological data needed to support research was a priority for Dr. Likens even before the Institute opened in 1983. He hired a consultant to advise on a site, then Laboratory Manager John Eaton coordinated the installation of instruments to collect and analyze not only precipitation (the "buckets on tables" are precipitation collectors) but also water samples from the East Branch of Wappinger Creek. Several years later, other meteorological instrumentation was added to expand the monitoring program.

The majority of the Environmental Monitoring Station instrumentation is in place at the Lovelace Drive site; stream-monitoring equipment is located at intervals along the banks of the creek. The Institute has nearly two decades of air quality, water quality and meteorological data used not only by its scientists, educators and display garden staff but also by meteorological professionals and the local media (the *Poughkeepsie Journal* weather page, for example, reports precipitation pH from IES measurements)*.

* The Institute's Environmental Monitoring Station data are on the Internet, at: http://www.ecostudies.org/research/emp/emppurp.html

The New York State Department of Environmental Conservation (DEC) monitors the concentration of ozone in the air in New York state to ensure that the air meets U.S. Environmental Protection Agency standards. With Poughkeepsie, N.Y. considered a critical area for monitoring, the DEC found that its numbers for ambient ozone in the city were lower than those recorded at the Institute's Environmental Monitoring Station, which was at that time under the supervision of Dr. Gary Lovett. IES subsequently agreed to the relocation of the DEC monitoring operation to the Institute's hilltop site.

LORNA KELLY

Victoria Kelly collects and records data at the IES Environmental Monitoring Station. The new monitoring shelter, here under construction, is to the right. Directly behind Kelly are two precipitation collectors.

By 2000, the two buildings at the site – one for IES instrumentation and the other belonging to the DEC – were showing signs of, well, weathering, and the Institute approached the DEC about building a new, shared facility. With DEC agreement to handle construction, IES engaged local Architect Robert Wills to design the structure, and construction began in summer 2001. Dr. Philip Galvin is the Section Chief for Eastern Monitoring Operations, NYS DEC. "We're very pleased that we have a monitoring shelter here at the Institute of Ecosystem Studies," Galvin says. "Our cooperative program is a good one, and the monitoring capability is very important for the measurement of ozone in the Hudson Valley."

Construction of the new facility and installation of instrumentation will be completed by spring 2002. This modern monitoring shelter will eliminate some of the duplication of effort that was unavoidable with the separate IES and DEC structures, and may facilitate an expanded program. ●

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Dr. Lovett chairs the Institute's Environmental Monitoring Committee; other members are Drs. Valerie Eviner, Peter Groffman, David Strayer and Kathleen Weathers, and Research Assistant III Victoria Kelly. Kelly has been collecting and collating data for the IES Environmental Monitoring Program since 1992, and maintains the environmental monitoring section of the IES website. Kelly will lead a Saturday Ecology Program to the Environmental Monitoring Station on May 4.

The Institute has just shipped 1300 pounds of scientific journals to the Universidad Nacional de Mar del Plata in Argentina. This contribution to the Department of Biology – Faculty of Exact and Natural Sciences was an effort that began during the summer when Dr. Oscar Iribarne, a scientist there, visited IES to collaborate with Dr. Clive Jones. During his stay, Iribarne spoke with the Institute's librarian, Ms. Chloe Keefer, about his hopes to fill in gaps in his laboratory's periodical collection. The two came up with a plan to ship copies of duplicate journals from the IES library to Mar del Plata; Drs. Jonathan Cole, Gene Likens and Michael Pace supplemented the effort with back issues from their own collections. Mr. Jorge Gutierrez, Iribarne's graduate student who spent two months at IES this summer (see the July-August 2001 issue of the IES Newsletter*), surveyed the Institute's duplicate periodicals to see what the laboratory could use, then Keefer and Ms. Cathy Gorham, library assistant, packed 38 boxes with the needed journals. Fourteen scientific publications made up the collection, and included* American Scientist, Ecology, Limnology and Oceanography, *and* Science.

IES scientists chipped in to pay shipping costs. Traveling to Argentina by ship, the journals are expected to arrive sometime during January 2002.

JILL CAGWALADER

At right: Chloe Keefer (foreground), Cathy Gorham, and 1300 pounds of boxed journals.

Spring Ecology Day Camp: March 25 - 28, 2002

Become an IES Junior Ecologist! ... If you're a 1st, 2nd or 3rd grader, join us for a four day adventure during your spring break:

• *ecology investigations* • *hikes* • *nature art projects ... and more!*

Camp will be at IES from 9 a.m. - 2 p.m., with a late pick-up option (to 4 p.m.) for parents who can't be here by 2:00.

For registration information, call the Education Program Office at 677-7600 ext. 316 or e-mail FordM@ecostudies.org. Deadline: March 18.

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Calendar

CONTINUING EDUCATION

For information, or to request a catalog, call the Continuing Education office at 845-677-9643 or visit www.ecostudies.org/education/continuing.html.
Winter semester programs include:

Gardening

Jan. 19 (4 sessions, every other Sat. through Mar. 2): **Plant Propagation - Basic Principles/Techniques**
Feb. 23: **Invasive Plants/Landscape and Garden**
Feb 28 (3 Thurs., 1 Sat.): **Hydroponics**

Landscape Design

Jan. 16 (7): **Graphics**
Feb. 26 (8): **Construction I: Grading and Drainage**

Biology & Ecology

Jan. 30 (6 Wed., 2 Sat.): **Introduction to Ecology**
Feb. 3 (4): **Basic Botany**

Natural Science Illustration

Jan. 13 (also the 2nd Sun. each in Feb., Mar. & Apr.): **Watercolors in the Greenhouse - Special Topics**
Jan. 26 (3): **Pen and Ink I: Techniques**

Workshop

Feb. 9 and Mar. 2: **Where Knowledge Meets Imagination: Writing About Gardens, Design, Plants and People**

SATURDAY ECOLOGY PROGRAMS

Come to **free public programs** on the first Saturday of the month. Pre-registration isn't necessary. If you have questions, call 845-677-7600 ext. 321 for information on upcoming programs:
Feb. 2: **Winter Is for the Birds!** [children age 6 and up, with accompanying adult(s)]
Mar. 2: **Ecology of Maple Sugaring** [children age 7 and up, with accompanying adult(s)]
Programs are from 1 - 3 p.m. and begin at the Gifford House Visitor and Education Center. Dress according to the weather for the outdoor programs.
There is no Saturday Ecology Program in January.

CHILDREN'S PROGRAMS

IES Ecology Field Programs for school groups continue throughout the winter months. Teachers may call the Education Office, at 845-677-7600 ext. 316, for information on "Plant Power" (fall, winter and spring, in the greenhouse) or "Ecology of Maple Sugaring" (Feb. 25-Mar. 22, outdoor program).

IES SEMINARS

Free **scientific seminars** are held at 11 a.m. on Fridays in the Auditorium. Seminars are free, and pre-registration is not necessary.
Jan. 11: *Title pending*. Dr. Karen Bushaw-Newton, Patrick Center for Environmental Research, Philadelphia
Jan. 18: *Information pending.*
Jan. 25: **Effects of Landscape Postition on the Biogeochemistry of Lakes in River Floodplains and Deltas.** Dr. Lance Lesack, Simon Fraser Univ., British Columbia
Feb. 1: **A Mechanistic Tree Migration Model to Simulate Holocene Spread of Forest Trees in Switzerland.** Dr. Janine Bolliger, Swiss Federal Research Institute
Feb. 8: **Fisheries in an Ecosystem Context.** Dr. James Kitchell, University of Wisconsin
Feb. 15: **Aquatic Birds as an Example of Conservation Medicine: Linking Animal, Human and Ecosystem Health.** Dr. Mark Pokras, Tufts Univ. School of Veterinary Medicine
Feb. 22: *Information pending.*

THE ECOLOGY SHOP

New in the Shop ... wooden walking sticks ... birdsong identification CDs ... roosting pockets for birds ... **for children** ... Burt's Bees all-natural baby-care products ... pen telescopes ... butterfly and birdhouse kits ... kids's binoculars ... **in the Garden Room** ... phone-paks ... assorted ceramic pots
Senior Citizens Days: 10% off on Wednesdays
*** * January Sale * ***
Month-long sale: 50% off all holiday plants (poinsettias, Christmas cactus, cyclamen) ... 20% off all regularly priced gifts, books and plants

GREENHOUSE

The greenhouse is a year-round tropical plant paradise and a site for controlled environmental research. Winter highlights include the begonia collection, the citrus collection, orchids and jasmine. Also, several banana plants are producing fruit.
The greenhouse is open daily until 3:30 p.m. with a free permit (see HOURS).

HOURS

Winter Hours: October 1 - March 30
Internal roadways closed when snow covered.
Use of trails may be limited by some weather conditions.
Free permits are required; available at the Gifford House Visitor and Education Center until 3 p.m.
Public attractions: Mon.-Sat., 9-4, Sun. 1-4; closed public holidays. The greenhouse closes at 3:30 daily.
The Ecology Shop: Mon.-Fri., 11-4, Sat. 9-4, Sun. 1-4.
(Please note: The shop is closed Mon.-Sat. from 1-1:30.)

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include subscription to the newsletter, member's rate for courses and excursions, a 10% discount on IES Ecology Shop purchases, and participation in a reciprocal admissions program. Individual membership: $40; family membership: $50. Call the Development Office at 845-677-7600 ext. 120.

The Institute's Aldo Leopold Society

In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call the Development Office at 845-677-7600 ext. 120.

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Street address: Gifford House Visitor and Education Center, 181 Sharon Tpke. (Rte. 44A), Millbrook, N.Y.

... IES website: www.ecostudies.org

For information on current IES public events and attractions, visit: www.ecostudies.org/welcome/ThisWeek.html.
For garden tips, follow the link to the Perennial Garden Archives.